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Technological Solution for Production, Storage, Offloading and Export of Condensate Produced from Israel's Offshore Gas Fields

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Introduction

The oil and gas business can be complicated. It is often influenced by personal interest, conflicting values and ideologies. This report presents a technological, legal and economic solution for installing an offshore CALM buoy for offloading and exporting condensate[1] from offshore gas fields in Israel, and it also aims to navigate through the aforementioned challenges commonly found in the energy industry with respect to condensate. According to a new government policy, further development of new offshore oil and gas fields[2] will be encouraged in the future and there will be a need to provide satisfactory solutions for disposing of additional condensate and other liquid byproducts that will be produced from such fields. This will be true for any chosen field development scenario in the future (as it was for Leviathan) - be it a *deep-water FPSO*[3] such as the facility being built for the Karish and Tanin fields, or a *tie back to platform* solution in the shallow water locations designated by the TAMA 37/H plan[4].

This report will introduce a premise that all field development solutions should include transparent decision-making processes and should account for factors such as environmental, safety, security, convergence, public interest, national and municipal considerations, energy security and principles of fair competition. It is important for the government to set an equal playing ground for new fields so as to avoid granting a technological advantage to one field over another which would *de-facto* enable one consortium to export condensate that they produce while another consortium would be tied to domestic markets only. As a matter of principle any offshore development solution must also provide suitable financial return for stakeholders, municipalities and local residents (for example the residents of Haifa, Hadera and Ashdod whom must regulate condensate stored in their vicinity).

Background on Condensate and the Relationship between the Leviathan Development Plan and the Government National Outline Plan (TAMA 37/H)

The Tama 37/H National Outline Plan (the "**Plan**") was approved in 2014 and established the planning principles for the receipt and processing of natural gas from offshore gas fields. The Plan was approved by the government following

1 Condensate is a form of liquid gas, which is a byproduct of the process of extracting and producing natural gas from their reservoirs. The condensate is a liquid fuel that must be stored and offloaded of in real time during the gas processing stage. Condensate can be transported in special pipes to refineries or to dedicated onshore storage tanks, or it can be transported in freight tanker trucks or maritime tankers. Condensate has economic value and its price is similar to that of a barrel of oil. The typical customers for this type of fuel are refineries and petrochemical factories.

2 See the Conclusions of the Professional Team for the Periodic Examination of the Israeli Government's Policy for the Natural Gas Market dated June 2021 – The second "Adiri Committee").

3 Floating Production Storage & Offloading Facility.

4 The Israeli National Outline Plan for Receiving Offshore gas ("Tama 37/H").

almost three years in which it was debated, revised and underwent public proceedings. The Plan was eventually confirmed by the High Court of Israel (Bagatz) after several petitions brought against it. The Plan was the initiative of the Ministry of Energy and it was facilitated through an Israeli planning firm. During the planning process several offshore field development scenarios were put forward which were eventually narrowed down by a panel of experts. The Plan was designed to be flexible and to find a balance between offshore and onshore elements of field development scenarios. At that time, numerous committees held additional proceedings on natural gas including offshore surveys and other government decisions were made which were intended to encourage a smooth transition from the use of coal and fuels to the use of natural gas. The transition to using cleaner energy sources by developing Israeli offshore gas reservoirs was the government's motivation for seeking the rapid development of Leviathan which was also intended to bring competition to the earlier Tamar field, commissioned in 2013.

The most significant of such additional proceedings was the final approval of the Gas Outline,[5] which paved the way for the expedited development of the Leviathan field. The final approval of the Gas Outline also led to public protests against the oil and gas companies as it coincided with the emergence of new perceptions about fossil fuels and their contribution to climate change. The public protest was also politically motivated and directed against the government and most aspects related to the Leviathan development plan.

A key factor that profoundly influenced the final outcome of the Plan was that it had been led by the government while the Leviathan Consortium[6] had no ongoing and/or permanent involvement. The decision not to include a permanent representative of the Leviathan Consortium in preparing the Plan ultimately led to a disconnect between the two sides during the process. While work was being conducted by the planning team in Israel, the Noble Energy ("**Operator**", now Chevron) planning team was busy preparing their version of the Leviathan development plan in Texas, USA. The irony was that on the one hand, the TAMA 37/H planning team (that included leading experts) were holding theoretical debates on possible alternatives for developing Israel's gas fields while on the other hand there was no direct and ongoing dialog between the local planning team commissioned by the government and a permanent representative from the Leviathan Consortium during these deliberations. This was especially noticeable in media announcements released at the time - while the planning team in Israel was discussing platform alternatives in territorial waters, the press was opting for developing Leviathan on an FPSO located the EEZ.

Among the plethora of contentious issues that were being tackled by the local planning team, the question of Leviathan's condensate was also being reviewed. In general terms, the amount of condensate produced from a gas field in a single day depends on the specific makeup of the gas reservoir. However, a link can be presumed between the amount of gas processed at any given time, and the amount of condensate that is produced. The amount of condensate that was originally expected to be produced during phase one of the Leviathan Field development plan was 572m^3/d, and during phase two will be 430 m^3/d (equaling a total of 1002 m3/d for both phases)[7]. At present, several thousands of barrels of condensate are produced per day from Leviathan.

On April 5, 2016, the National Planning and Building Council approved the onshore-offshore development scenario mix for Leviathan and not long following that the Leviathan Consortium finally submitted their version of the Leviathan field development plan, in conformance to the Plan.

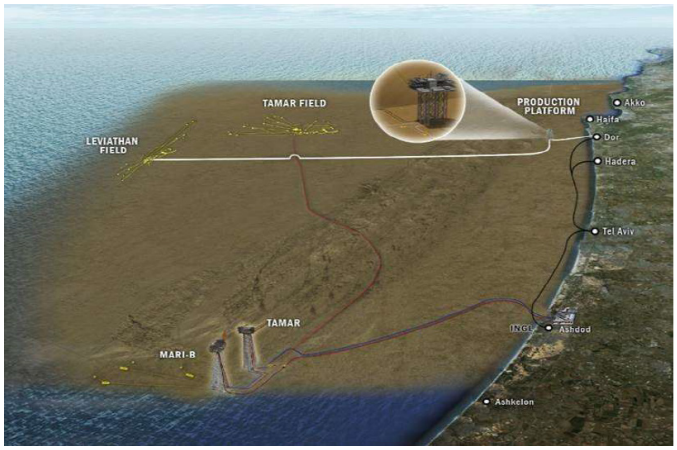

Figure 1: Illustration of the Leviathan Development Plan layout[8]

5 Government decision 476 dated August 16, 2015 – the Gas Outline

6 The Leviathan Consortium is comprised of Delek Drilling (45.33%), Ratio (15%) and Chevron Mediterranean Limited (39.67%)

7 Leviathan Omissions Permit in accordance with the Clean Air Law – 2008 (Granted in 2019), Page 2

8 Noble Energy Mediterranean Ltd (NEML), Leviathan Production Platform Installation, Commissioning and Field Sub Sea Oil Spill Contingency Plan (OSCP) – Tier 4 dated January 16, 2019

Phase One of the Leviathan field development came into operation in 2019. With respect to the Leviathan condensate, the Operator decided to use a combination of both offshore and onshore pipelines designated for condensate transmission which were to tap into existing pipeline infrastructure onshore belonging to the Europe Asia Pipeline Company Ltd ("**EAPC**"). The EAPC owned onshore pipeline had been built decades ago, and its route continues northward toward the Haifa Oil Refineries ("**Bazan**"); thus, the EAPC pipeline had the capacity of transmitting projected amounts of Leviathan produced condensate directly to the Haifa Oil Refineries.

For the TAMA 37/H planning team this decision came somewhat as a surprise. After all, the Plan's purpose was to designate areas for construction of new infrastructure for Leviathan. However, the Plan did not clearly specify if and how it would address connecting the new infrastructure to already-existing third-party infrastructure (such as the EAPC pipeline).

The use of the existing EAPC infrastructure, with convenient access enroute the Plan near Maayan Zvi, was made possible through a commercial agreement signed by and between EAPC and the Leviathan Consortium, and not in light of any explicit pro-active instruction included the Plan. On the other hand, the National Planning and Building Council did pro-actively mandate construction of a backup tank for condensate storage to be located at the Hagit site (in northern Israel) and this was to be done through a newly built dedicated pipeline from the Dor Valve Station (DVS) to Hagit. The construction of the backup storage tank at Hagit was approved as part of the onshore-offshore development mix for Leviathan in accordance with TAMA 37/H whereas the EAPC pipeline tap in was not mandated in the Plan, per se.

Figure 2: The condensate pipeline route from the Dor Valve Station ("DVS") to the "Hagit" site

And as such, there became two actionable alternatives for transmitting condensate from Leviathan: One via a pipeline network *tap-in* leading to Bazan, and the other via a newly constructed pipeline leading to a storage tank at the Hagit site to be used for emergency purposes only.

The Challenge of Offloading Condensate from Offshore Gas Fields such as the Leviathan Field

The true extent of the challenge of offloading condensate from Leviathan only fully transpired upon and after commissioning of phase one of the field in 2019. The main concern was that Bazan were not very keen on buying the entire amount of condensate from the Leviathan field in the first place. One might say that piping the entire amount of condensate produced from Leviathan to Bazan had practically been forced upon them under tremendous political pressure. Both Oil Refineries in the north and south of Israel had already accumulated considerable experience interacting with the Operator with respect to condensate during previous offshore developments and they fully understood the implications of condensate to the Operator. Bazan realized that they were in a good bargaining position on the condensate issue and they were in no hurry to solve any complications on their own. Moreover, Bazan had their own business model in mind, and also future plans – they fully understood, in real time, that they could leverage the condensate predicament to their advantage. As such, this placed the Leviathan Consortium at a disadvantage at the beginning of the condensate transmission negotiations and it was only following tremendous pressures due to the hectic timetable for timely completion of the Leviathan field development that the parties eventually agreed to make some compromises and strike a deal. In the background of course were various pressures and decisions regarding the implementation of the Gas Outline.

Under these circumstances, the Leviathan Consortium eventually signed a commercial agreement with Bazan, EAPC and Petroleum Energy Infrastructures Ltd ("**PEI**") which allowed for the use of existing infrastructure for the transmission of Leviathan condensate to Bazan and PEI; thus, these agreements finally allowed the completion of the Leviathan development on time. These agreements also imposed a sizable financial burden on the Leviathan Consortium which has to this day not been resolved.

And therein lies the problem - offloading condensate from Leviathan is now dependent on its transmission to

Bazan through onshore pipeline and infrastructure owned and operated by third parties whilst imposing financial loss to the Leviathan Consortium. On top of that the additional alternative of an emergency storage tank at Hagit mandated by the Plan was only permitted on the condition that it would serve for emergencies only (with almost no options to transmit condensate onwards to paying customers for commercial purposes).

Figure 3: Construction of the Condensate Tank at Hagit for the Leviathan Project[9]

The Hagit condensate storage tank that was eventually constructed by the Operator can hold a maximum capacity of 10,000 M3 of condensate and reaches a diameter of 37 meters. It contains an aluminum dome roof & floating roof and uses a special hydraulic lifting system.[10]

It follows that any change to the status-quo regarding transmission and storage of Leviathan condensate vis-à-vis third parties, whether due to a malfunction in the EAPC pipeline or due to future closure of Bazan or for any other reason will place a big question mark over the continuing operation of Leviathan. One must bear in mind that interruption of the flow of condensate from Leviathan could also lead to the halt of gas processing altogether. In other words, an equation has emerged whereby cessation of gas processing from Leviathan will undermine Israel's energy security and also impair the energy security of Leviathans regional customers that depend on Leviathan gas.

The conclusion therefore is that there is clearly great interest to develop additional condensate offloading alternatives for Leviathan during phase two of the Leviathan Development Plan, and also for all the new fields to come. Any additional operational methods that may be introduced for condensate will significantly enhance the operational, environmental and economic aspects of Leviathan. With future outlook in mind, as gas processing from Leviathan is expected to gradually increase for export purposes during phase two, together with the projected increase in domestic gas consumption, there will be greater need for additional offloading, transmission and storage facilities for condensate. Additionally, there will also be a need to develop new target markets for the condensate in Israel or abroad as currently in Israel there is insufficient demand for all of the condensate produced from the Tamar, Leviathan, Karish and Tanin fields combined.

Figure 4: The Orot Rabin Power Plant as a preferred location for the construction of a Condensate Farm for export purposes

And therefore, it came of no surprise that the Leviathan Consortium recently presented a plan for a new collaboration with PEI for constructing a condensate storage farm on the Israel Electric Corporation's premises at Orot Rabin[11]. This location is ideal for storing condensate since it is on the route of the dedicated sea-to-shore piping from the Leviathan platform. The site will soon convert to consume natural gas and there will be no need for the large coal storage spaces and other facilities. Furthermore, the site is located on the sealine with direct access to offloading facilities and easy access to the Leviathan platform. Conceptually, such a plan is very practical and economical and perhaps even indispensable. On the other hand, it could potentially

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10 Information provided by Grand Ofek Projects (www.g-o-p.co.il) for academic purposes only.

11 ענת רואה, צעד ראשון לפינוי בזן? אסדת לווייתן נערכת לנתק התלות בבתי הזיקוק, **כלכליסט**, 27 ביולי 2021 https://www.calcalist.co.il/local_news/article/hjmbtdp0d

increase the risk for environmental hazards. Such risks could also trigger objections from the local populace.

The TAMA 37/H plan did not specifically address the planning and constructing of future export facilities. The planning team was fully aware that this possibility might exist in the future, however the operative decision at the time during the preliminary planning stages was to focus exclusively on the needs of the State of Israel. Such planning was to be done within the boundaries of Israel and only for Israeli needs. Therefore, the planning team did not examine in detail options for developing infrastructure for the international export of oil, gas and/or condensate to markets abroad. This operative decision was never applicable however to the Operator's planning teams in Texas which pursued all matters relating to the field development for Leviathan in great detail. It also didn't apply to the Karish and Tanin Operator and as such, in comparison, the upcoming Karish and Tanin FPSO intends to store its condensate for export on board their FSPO. The offloading of condensate from the Karish and Tanin field for export purposes will be conducted by *ship-to-ship* transfer in deep water in Israel's exclusive economic zone ("**EEZ**").

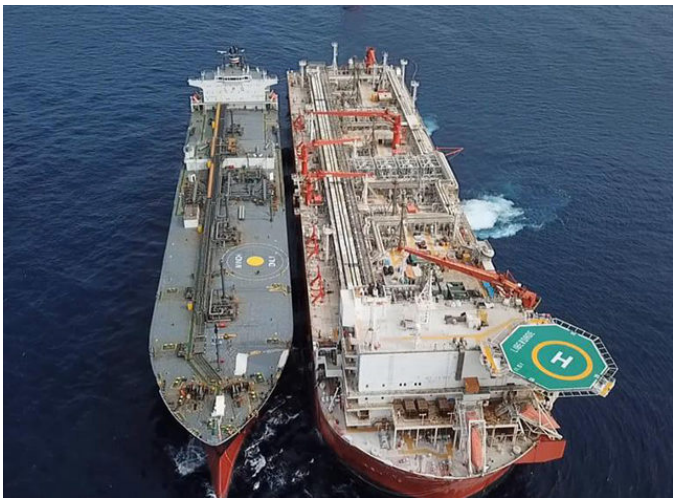

Figure 5. FSO to Condensate Tanker – Ship to Ship Transfer (Example)

The Karish and Tanin field operator will be technologically able to export their condensate to international markets directly from offshore, without being bound to a network of third-party infrastructure onshore. Leviathan on the other hand will be exclusively bound to the domestic markets in reliance on a third-party infrastructure network which they do not own and which may not be fit for the future needs of Leviathan. This is also a competitive issue which requires further analysis.

During the early stages of the Plan, the planning team introduced several solutions for processing gas and condensate offshore. One of the alternatives presented was an offloading buoy for condensate which could be positioned near the platform and could be used for offloading condensate directly from the platform to tankers. At the time, the Plan was intended to be very enabling, and it included several possibilities for both onshore and offshore segments. The offshore buoy solution that was presented was not outright rejected but rather it was just not chosen to be developed at the time. The reasons why the offshore buoy solution for condensate did not materialize in practice are varied and complicated.

First, the government led by the Ministry of Energy took a general position that onshore alternatives were better for Israel from a public interest perspective and therefore the benefits of onshore interests were reflected in the government led debates consistently and over time. On this, the general public was surprisingly slow to respond. It was only after some time that the initial public opinion gelled demanding that all gas processing facilities should be located offshore and not onshore, mostly due to environmental, health and classic NIMBY considerations ("**Not in My Backyard**"). At the early stages of the Plan, public opinion did not distinguish between offshore facilities close to shore (in shallow-water) and deep-water floating facilities (in deep water). Their initial responses to the government's stand were that all gas processing facilities should be positioned offshore. Period! It was only after the debate intensified that this message attained more granularity and a new position materialized, slightly belatedly, demanding that all of the gas processing facilities should be located "*above the well*" in the EEZ and not inside territorial waters.

Second, environmental consultants who were members of the TAMA 37/H team prepared reports and simulations that demonstrated extreme scenarios resulting from a spill or attack against a condensate tanker opposite Israel's shores. Such simulations and statistical assessments were conducted painting this alternative as extremely dangerous and unattractive. Some might say in response that there were really no grounds for rejecting offshore alternatives based on such predictions since at any given moment there are dozens of tankers and/or buoys at sea opposite the ports of Haifa, Ashdod and Ashkelon. Such risks are often managed using

risk management processes, professional operations and appropriate regulatory oversight. Moreover, compared with oil, condensate is a light fuel which floats and evaporates on the water and is not at all similar to the hazards posed by an oil spill. Also, the actual position of an offshore buoy could easily be positioned outside the territorial waters in the contiguous zone or in the EEZ which would reduce these scenarios significantly.

And third, the cost of constructing and operating an offshore alternative is usually very expensive. As a general rule of thumb, an offshore alternative will always be more costly than an onshore alternative. Construction of an offshore buoy, which will also require offshore offloading, transport and operations using tankers would impose higher OPEX costs on the Operator, compared with all of the other onshore alternatives. In fact, the choice of the onshore alternative for condensate substantially reduced the initial CAPEX required for developing the Leviathan field in its initial phase. This is a purely economic consideration.

High Court Petition (Bagatz) 2974/17 – Megiddo Regional Council et al Vs. National Planning and Building Council et al (the "Megiddo Petition")

In 2017, as the Gas Outline and the Leviathan Development Plan were reaching their boiling point, public protest on these matters became vociferous. The question of the legality of transmitting condensate to shore was brought before the High Court of Israel in the Megiddo Petition. The Megiddo Petition dealt with a question of principle: Was the decision to allow the development of the Leviathan in a configuration which includes a backup condensate storage tank at the onshore Hagit site lawful? This High Court (Bagatz) ruling is significant mostly due to the arguments brough forth with respect to the examination of alternative offshore solutions for offloading condensate.

Starting from the end, the Megiddo Petition was ultimately rejected and the Plan was again determined lawful, thus paving the way for the expedited development of Leviathan in its current configuration. However, the arguments brought forward by the petitioners and the responses introduced by the respondents can shed light in hindsight on the mindset at the time. Perhaps some of the arguments made against the practical implementation of offshore solutions for condensate in the Megiddo Petition would not, or should not have been raised at all in view of how these matters played over recent years.

In their ruling, the judges first noted that the dispute over the approval of TAMA 37/H had already been settled in previous petitions and they were not willing to review the matter again. They cited a previous petition (Petition 7737/14 - Yokneam Municipality vs. the National Planning and Building Council) which concluded that the planning process for TAMA 37/H was “professional, unbiased and orderly, and that it was faultless”.

However, during the hearings on the Megiddo Petition, some arguments were brought in opposition to several of the offshore solutions for condensate (such as a buoy or an underwater tank), *inter alia*, it was implied that from a security perspective – the task of protecting more than one offshore facility at the same time (such as a platform and a buoy) could be impractical or somewhat difficult to carry out.

Figure 6. The new Israeli Navy "Saar 6" Corvette

It was also argued that continuous offloading of condensate offshore during an emergency or in high seas could be very challenging on the Operator. It seems that the purpose of these claims was to unpopularize the offshore options and tip the balance in favor of erecting an emergency onshore storage facility at Hagit which was a government-led initiative. In retrospect and given the Israeli Navy’s current defense capabilities which includes new ships and sophisticated technologies designed to protect multiple offshore targets, and who have been empowered by the government to protect Israel's EEZ, the merit of such an argument seems to be weaker at present date. Even if such an argument was true several years ago, it is doubtful that it would be supported today by the qualified authorities. Moreover, points raised during the Megiddo Petition with respect to difficulties in carrying out operations during

emergencies or high seas seem arcane today, especially in light of the Karish and Tanin FPSO in the EEZ which will include offshore condensate offloading capabilities. Again, this is another matter for competitive review.

Figure 7. Energeian Power FPSO in development for the Karish and Tanin Fields

But interestingly, the Operator's position during the Megiddo Petition hearing seemed quite precise and non-confrontational. The Operator did not attempt to discredit the offshore alternatives nor to determine what was preferable or easier for them to operate. They focused their arguments solely on the implications and impacts on the timetable of the Leviathan project stating that a change to the development plans for Leviathan would cause a significant delay in the project timetables. This form of argument is quite precise from both a technological and legal standpoint since it does not reject offshore alternatives and neither does it specify what would be preferable.

The main argument at the time was that any change in the development plan for Leviathan would require thorough investigation and the immediate ramification of such an investigation would have been a delay in developing the field. The Operator's strength in this case was to understand, *in real time*, what the overall map of interests were in Israel both at the present time and in the future. Their commitment at that time was to the project timetable.

At that point in time, the Operator was committed to develop Leviathan under the "Gas Outline", and committed to the banks and their partners through financing and debt, and also committed to their project execution contractors - each of these had a dire interest to complete the project on time. For this reason, all of the offshore solutions suggested in the petition were deemed unsuitable, but could easily be readdressed in the future outside the context of the initial Leviathan development timetable.

Technological Solution for Production, Storage, Offloading and Export of Condensate Produced from Israel's Offshore Gas Fields – a "CALM" buoy

So where do we go from here? Following the successful commissioning of phase one of the Leviathan field, the time has come to revisit some of the offshore solutions for condensate offloading that were reviewed in the past as we approach the timeline for phase two and future field developments. It could very well be that for export purposes of condensate – offloading condensate offshore would be preferable to transmitting and storing export ladened condensate to shore.

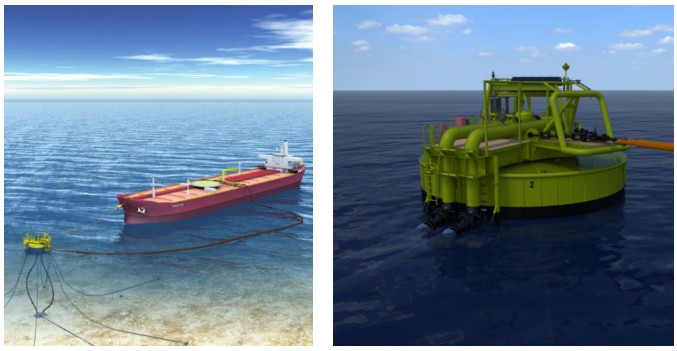

Figure 8: An SBM IMDOCO "CALM" Buoy

The underlying purpose of this report is to highlight advantages of installing an offshore Catenary Anchor Leg Mooring ("**CALM**") buoy for offloading condensate for Israeli offshore fields. As a test case, both the Leviathan field and the Tamar field could benefit from applying this option. By using an offshore CALM buoy, by or nearby the Leviathan Platform for example, condensate could be offloaded offshore immediately after its production and transferred via an offshore pipeline directly to an offshore CALM buoy. Via the CALM buoy, the condensate could be transferred to sea bearing tankers anchored nearby. A CALM buoy (of whichever kind or nature) would be permanently anchored to the seafloor using a Catenary Anchor Leg Mooring system. Such CALM buoy could be positioned in shallow water or deep water at depths of between 20 and 1,000 meters or more. If so desired, a CALM buoy could be placed 10 km away from the Platform outside the territorial waters in the contiguous zone. A CALM buoy's anchoring system could be suited to any kind of weather and would facilitate quick

disconnect capabilities in case of need. Currently around the world there are over 500 such buoys (including in Israel) and this is by no means a technological breakthrough.

There are varying degrees of outfitting for each CALM buoy which is designed according to the needs of the particular field and according to the operator's requirements. The level of operation and applied safety measures would be determined by the operator and under government supervision.

The unmistakable commercial advantage of offloading condensate via a CALM buoy at sea, over the other onshore alternatives is that the condensate can be sold to the Israeli market and/or worldwide without being bound to a single buyer at the end of a pipeline or third-party infrastructure. For Leviathan, for example, positioning a CALM buoy next to the Leviathan Platform or in its vicinity would allow offloading condensate for domestic customers in Israel and enable surpluses to be exported directly – an option not currently available to them.

Another advantage of a CALM buoy would be to avoid transmitting surplus condensate for export to onshore facilities located in close proximity to population concentrations. Operating CALM buoys is common worldwide. The project CAPEX and OPEX can be strictly controlled and can vary from project to project. The onshore footprint would remain low. Purchasing an existing CALM buoy could shorten the development timetable and reduce construction costs. Assembly of the CALM buoy components could be facilitated at local ports. CALM buoys for export purposes could be integrated with already existing natural gas processing infrastructures, such as the Leviathan or Tamar platforms.

From the statutory standpoint, TAMA 37/H has already considered the possibility of including an offshore CALM buoy for condensate and it is safe to assume that placing an offshore CALM buoy in the vicinity of the Leviathan platform or even outside the territorial waters would be a possible solution subject to obtaining permits should the Operator and/or the Government of Israel wish to do so. Moreover, choosing to position a CALM buoy outside the territorial waters would mean a simplified, quicker process of obtaining permits and licensing at a location where the Israeli Planning and Building Law[12] does not apply.

A CALM buoy could be added as an operative alternative in addition to, and not necessarily instead of, the already existing condensate transition pipeline to shore. It would also be possible to consider placing a CALM buoy as a temporary solution until completion of suitable storage tanks near Orot Rabin. The more possibilities for storage, backup and transmission of condensate to both offshore and onshore locations will make it possible to commercialize the product more efficiently for each of the Leviathan stakeholders, the State and the citizens of Israel. The more difficult it becomes for transmitting condensate to shore due to stringent regulation, public pushback, third party infrastructure, lack of a motivated customer or just lack of physical storage together with the ever-complicated environmental aspects, the greater the motivation and economic will be to find better offshore alternatives.

Summary & Recommendations

As such, it is recommended that new solutions for offshore production, offloading and of condensate for export from Leviathan, Tamar and other offshore gas fields should be revisited through a transparent decision-making process taking into account factors such as protecting the environmental, safety, security, convergence, public interests, fair competition, export, national and municipal considerations, financial gain and national energy security aspects – these interests should be included in the decision-making process. The installation of a CALM buoy for export of surplus condensate from Leviathan, Tamar and new fields could be the preferred solution at this time.

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12 The Planning and Building Law, 1965